Letters to the Editor.

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Scientific Work: Its Spirit and Reward.

THE true incentive of the scientific worker is his work. Through his work he expresses the creative thought within him, which he feels to be his highest life. This expression must through its very nature be free, otherwise he becomes a slave in the worst sense, in that the free exercise of intelligence is denied him.

Because this freedom is sacred to the scientific worker he sometimes has to sacrifice income and the possibility of family life to retain it, but this is a mere misfortune, not in any sense a necessary concomitant of scientific ability. The sentimentalist and the exploiter have promulgated the idea that the scientific worker, being exalted above the need for normal human joys and amenities, works best on the smallest possible income; or, having found that this does not always work out in practice because it tends to reduce the output of useful results, as the reduction of rations to one bean per day led to the unfortunate demise of the horse, the opposite line is taken, and it is supposed that by large remuneration the valuable work looked for can be bought.

Neither the one nor the other point of view is correct. The scientific worker if he is normal needs the means to enable him to have a happy, care-free home-life, and to educate his children in such a way that they in turn may be free as he would be. Therefore to starve him is to eliminate the normal and consequently intelligent worker in favour of the eccentric. For let it be clearly stated, the highest intelligence is always supremely sane. The idea of a scientific worker as a harmless lunatic is by no means confined to sensational fiction, although it might as well be imagined that every long-haired user of a piano is a Paderewski, or every loose-tied splasher of paint on canvas a Sargent.

On the other hand, to believe that creative thought can be purchased with money is to repeat the mistake of Simon Magus. Imitative thought in all its manifestations can be obtained for an adequate remuneration, because it can be produced by outward drill, discipline, and experience. So experts in the orderly routine dear to the official mind can be turned out by mass-production like cheap crockery, and are similarly useful and indispensable.

There is however, no means of estimating the value of one really original thought either in pure or in so-called applied science. Certainly the possession of anything like its value in money would often be an embarrassment to the scientific worker through whom it is expressed. He also would be the first to disclaim any absolute or exclusive right to it. In the last analysis, humanly speaking, there is no such thing as an absolutely original idea, and it is seldom that any single individual can claim undivided credit for bringing a new idea to birth.

On the other hand, to divide its money-value, if it have any in such a way that little or nothing comes back to the immediate originator is simply unjust, and therefore ultimately disastrous.

A certain type of person sniffs at Lord Kelvin for having become part owner of numerous important patents. No one will deny Lord Kelvin's position as a scientific worker; that he was also a business man merely means that his gifts were more readily applied to the good of humanity.

That a scientific worker should be debarred from any reward or protection by patents embodying his discoveries, because of his occupying either a public or private salaried position, is not only unjust, but also often unbusinesslike and against the public interest. The equitable adjustment of rights and returns as between public or private capital and the actual inventor is often the only way to prevent exploitation by purely selfish private interests.

To repeat, the true incentive of the scientific worker is his work. Salary, kudos, position, *esprit de corps*—these are incentives to good and useful people, but they are not the true incentives of the real scientific worker. To obtain the best from him, he must before all things have freedom, and, if possible, also a reasonable measure of justice.

"The bearings of this observation," as Capt. Bunsby in "Dombey and Son" remarked, "lays in the application on it."

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Applied Science and Industrial Research.

AT a meeting held at the Birkbeck College on April 28, organised by the National Union of Scientific Workers to urge more public support of scientific research, Prof. Soddy, the principal speaker after Mr. H. G. Wells, who occupied the chair, made a strong attack on the Department of Scientific and Industrial Research and the industrial research associations which have been, and are being, established under its ægis (see NATURE for May 6, p. 309). As much of Prof. Soddy's criticism seems to lend colour to current misconceptions of industrial research and of the functions of the research associations fathered by the Department of Scientific and Industrial Research, I beg the hospitality of your space for the following observations.

No one disputes the vital and urgent need for increasing the facilities for scientific study and scientific research. All those who know the facts will echo Mr. H. G. Wells's just indignation at the national neglect of science and the half contemptuous treatment by the State of our great men of science. I go further and agree with Prof. Soddy that in the extension and intensification of scientific study and research the claims of pure science must be primary and paramount. But I deny emphatically that this involves a similarly short-sighted and contemptuous attitude towards the needs of applied science and industrial research. If English industry has suffered too long from the dominance of mere rule-of-thumb methods; if our manufacturers have, through ignorance, underrated the value of science, the fault has not been wholly and exclusively theirs. The academic people who have contemned applied science and industrial technology as something little better than a crude empiricism must bear some share of the blame. The manufacturer may have kept his feet too much in the mud; the academician has too often kept his head entirely in the clouds. If one has been too disdainful of scientific methods that did not ensure or promise immediate dividends in cash, the other has talked at times as though the mere prospect of a utilitarian issue to a specific research were enough to defile it and make it unworthy of his serious attention. We all know the type of academic science worker to whom an investigation of the internal structure of the atom is a noble and purifying pursuit, and

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a research on soap an ignoble and degrading occupation; as though atoms *per se* were inherently dignified and only became disreputable when associated with other atoms to form the molecules of a useful, if homely, commodity. There are many forms of snobbery. Pure science itself has had to put up with a good deal of classical snobbery, as Mr. Wells has more than once testified. I doubt whether matters will be mended by a development of such a form of scientific snobbery as seems often to be the inspiration of the disparagement, in academic circles, of applied science and industrial research.

Fortunately this attempt to erect an arbitrary and artificial barrier between pure and applied science is becoming progressively discredited as the nature of industrial research and its dependence on pure science are becoming better known. Every research in applied science, if it is to be thorough, involves some research in pure science. An industrial problem may be, and often is, the starting-point of a research that may widen the bounds of knowledge as much as any research born of a conception in pure science. Applied science and industrial research have been developed more widely in America than in any other country, if we except Germany. How does American experience confirm the view that to foster industrial research is to starve pure research? In the paper on "Industrial Research in the United States of America" by Mr. A. P. M. Fleming, published for the Department of Scientific and Industrial Research, there is abundant testimony to the recognition, by firms and institutions engaged in industrial research, of the importance of pure science research. Such an industrial leader as Dr. J. J. Carty, vice-president of the American Telephone and Telegraph Co., in his presidential address to the Institute of Electrical Engineers in 1916, emphasised this view: "By every means in our power, therefore, let us show our appreciation of pure science, and let us forward the work of the pure scientists, for they are the advance guard of civilisation. They point the way which we must follow." Mr. Elihu Root, chairman of the board of trustees of the Carnegie Institution of Washington, in a paper on the need for organisation in scientific research, makes the same point: "While the solution of specific industrial problems and the attainment of specific industrial objects will be of immense value, the whole system will dry up and fail unless research in pure science be *included within its scope*." Mr. W. A. Harmor, assistant director of the Mellon Institute of Industrial Research, University of Pittsburgh, bears similar testimony to the needs of pure science: "The wide view is now taken that, in considering the needs of industry, pure science investigation has as essential a contributory function as that specifically devoted to the attainment of some technologic objective." One could multiply almost indefinitely such tributes to the primary and paramount necessity of investigations in pure science from men and organisations concerned mainly with industrial research. Prof. Soddy's argument that for the million of money which the Government has expended or earmarked for scientific research pure science has got little or nothing is, therefore, based on a misconception of the nature of industrial research, and is directly contradicted by past experience and present knowledge.

The assumed antagonism between pure and applied science is baseless in fact and mischievous in tendency. As Mr. Harmor has well said: "Both pure and applied research are of the same order of importance and each has its own related field." The alleged inferior character of applied research as compared with pure research has no better foundation in fact than the alleged inferiority of scientific studies, as instruments of intellectual training, to classical studies. As Mr. A. W. Mellon, president of the Mellon National Bank of Pittsburgh, in an article on the value of industrial research, aptly expressed the matter: "The fundamental differences between pure research and industrial research are, indeed, traceable to the differences in the poise and personality of the representatives of each type of scientific investigation. Success in genuine industrial research presupposes all the qualities which are applicable to success in pure science, and, in addition, other qualities, executive and personal, more or less unessential in the pure research laboratory."

It would be strange if it were not in line with other experience that every time an attempt is made to extend and foster applied science and industrial research someone raises the cry that pure science is thereby being neglected and starved. This is to argue as though the total fund, both of money and energy, available for the purposes of scientific education and research were a fixed fund, so limited that any amount devoted mainly to the purposes of applied science must thereby lessen the sum available for pure science. It is a fallacy on a par with the trade-union notion that increased production by the individual worker will increase unemployment, and, by augmenting the profits of the employers, diminish the wages of the employees; and it is a proof, if proof were needed, that academic trade unionism can be as selfish and short-sighted as any other kind. Yet, just as the present condition of Europe affords a plain proof of the economic truth that the weakness of one nation impairs the strength of all, so will the cause of pure science not be bettered, but rather worsened, by attempts to crab the progress of industrial research.

The Department of Scientific and Industrial Research, as Sir Frank Heath has well said, is engaged on a great adventure. Thanks largely to its efforts, already the spirit of science is stirring among the dry bones of industries to which it was previously little known. The research associations formed and to be formed, which will cover a wide and diversified area of British industry, are attracting, and are destined to attract, scientific workers of the highest distinction and widest outlook, among them, no doubt, many of the members of the National Union of Scientific Workers, under whose auspices Prof. Soddy made his attack on the Department and the research associations. I submit that the cause of pure science is not well served by inconsiderate attacks on this industrial research movement, which is admittedly a novel experiment, beset by unforeseen, because unprecedented, difficulties, but the success of which must react to benefit pure science as well as to redeem British industry. J. W. Williamson.

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A Rainbow Inside Out.

In February last Mr. P. H. Hepburn directed my attention to some surprising light-bows he had observed on several occasions on the surface of one of the ponds on Hampstead Heath. On February 24 we examined them together. A footpath lighted by three electric street-lamps runs along the southern edge of the pond. As one passed along this path bright bows of strange forms cast by the lamps were seen to spring out from the edge. The night was dark, the air still and slightly foggy, and the water smooth and covered with a film of scum extending as far as we could see in the dim light. There was no frost. The bows were judged to be on the surface

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